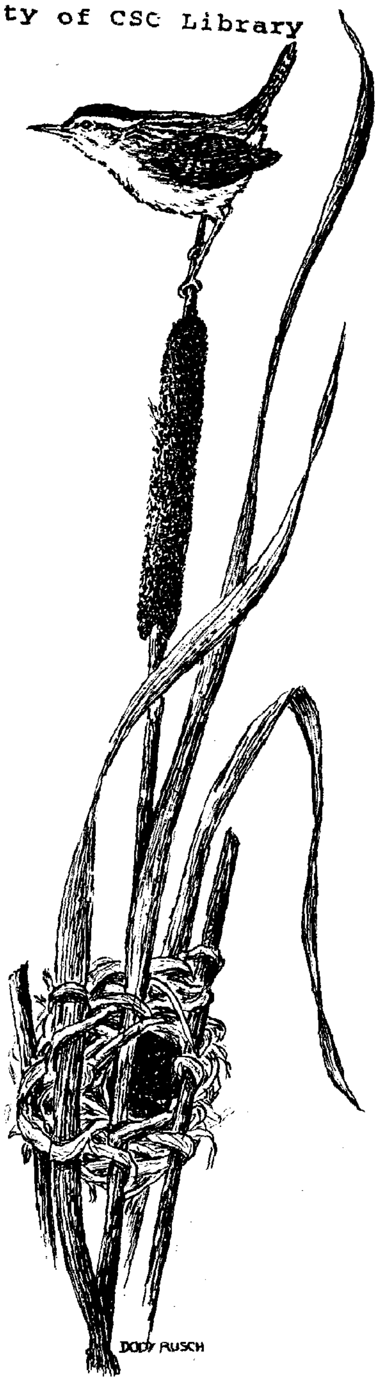
Wisconsin Wetlands

Wisconsin, U. of, — Extension



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Financial assistance was provided in part by the Wisconsin Board of Soil and Water Conservation Districts and the Wisconsin Department of Natural Resources.

The authors acknowledge the helpful comments received from the many reviewers of this publication—their assistance was invaluable.

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Wetlands once covered about one-fourth of Wisconsin's 35 million acres. But today many of our wetlands are gone. They have been drained, filled, and changed in other ways. Nearly half of the state's original wetlands are now used for agriculture, while many additional acres are covered by highways, railroads, houses, factories, and businesses.

Some parts of Wisconsin are still rich in wetlands, both in terms of total acreage and in the variety of wetland types. But in other parts of our state, most of the wetlands have been converted to other uses, and the pressure for conversion continues to grow. Today we realize the importance of conserving wetlands.

Wetlands store flood waters, provide food and shelter for wildlife, and improve the quality of water entering our lakes and streams. Near urban areas, wetlands provide open space and often serve as outdoor classrooms.

How do we resolve the conflicting demands for the use of wetlands? There is no easy answer. We must weigh the value of wetlands against the value they would have if converted to agricultural production, urban development, or other uses. The purpose of this publication is to provide information to help people come to their own decisions on how we should manage the state's wetland resources.

We begin by defining wetlands in terms of their relationship to water, soils and plants. The second section discusses basic ecological concepts helpful in understanding how a wetland functions. The third section describes values of natural wetlands as well as their values when altered for urban, agricultural or other uses. The final section discusses the economic and legal aspects of decisions concerning wetland use. It also describes tools governmental agencies can use to guide decisions about wetland use.

WHAT ARE WETLANDS?

Marshes, swamps and bogs are familiar names, and all are wetlands. But have you ever heard of a wet prairie or a sedge meadow? They are wetlands too. All types of wetlands have one thing in common—they are **wet**, ranging from places where the soil is waterlogged to areas covered by shallow, standing water. Wetlands constantly change. As they shrink and swell with seasonal and annual changes in water levels, their plant and animal communities also change. Wetlands support a wide variety of water tolerant plants, ranging from submerged plants to trees. Wetlands may have organic or mineral soils or a mixture of both. As you can see, wetlands are complex natural systems. However, we can simplify this complexity by separately discussing wetlands' relationship to water, their soils, and their plants.

Water in Wetlands

Wetlands are part of the hydrologic cycle—the movement of water from the sea to the air to the land and back again to the sea. As Figure 1 shows, some of the water which falls on the land runs off into streams. Some of it evaporates or is transpired through plants, and some filters into the groundwater system. In Wisconsin, water usually enters the groundwater system in upland **recharge** areas. (Water entering the groundwater system recharges it; water leaving the system is a discharge.) The water seeps down through the soil until it reaches the water table—below which the rock or soil is saturated with water. Then it seeps through the soil and rock to **discharge** areas such as springs, lakes, streams, and wetlands.

Figure 2 is a topographic cross section illustrating groundwater flow and the relationship of wetlands to groundwater. It shows that wetlands are usually an exposure of the groundwater table, but some are perched above it over impervious bottom materials.

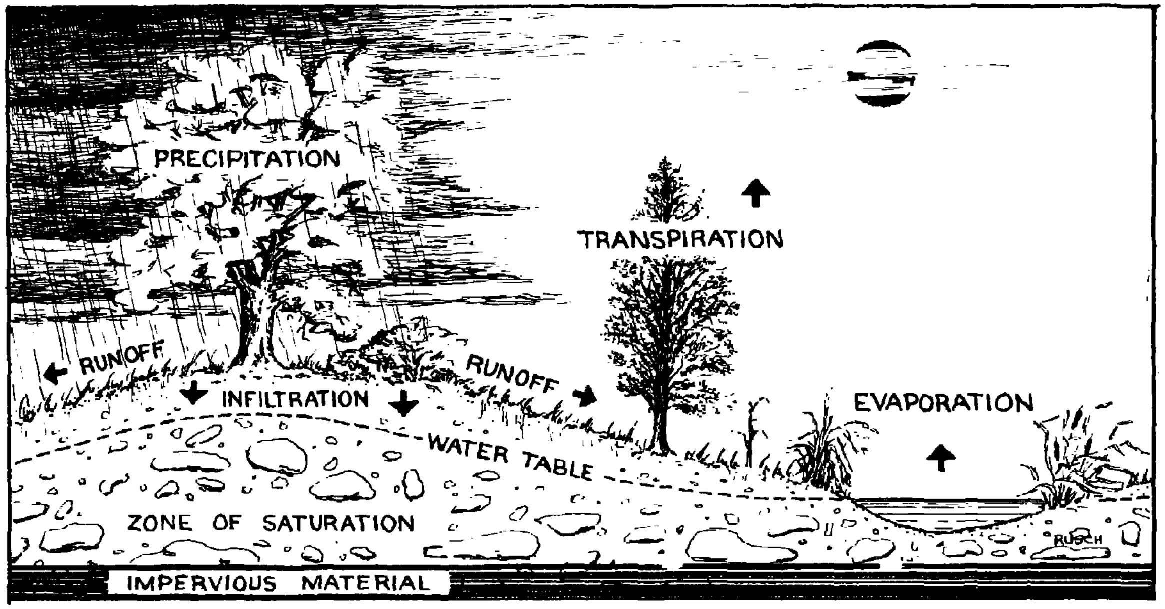


Fig. 1 The Hydrologic Cycle

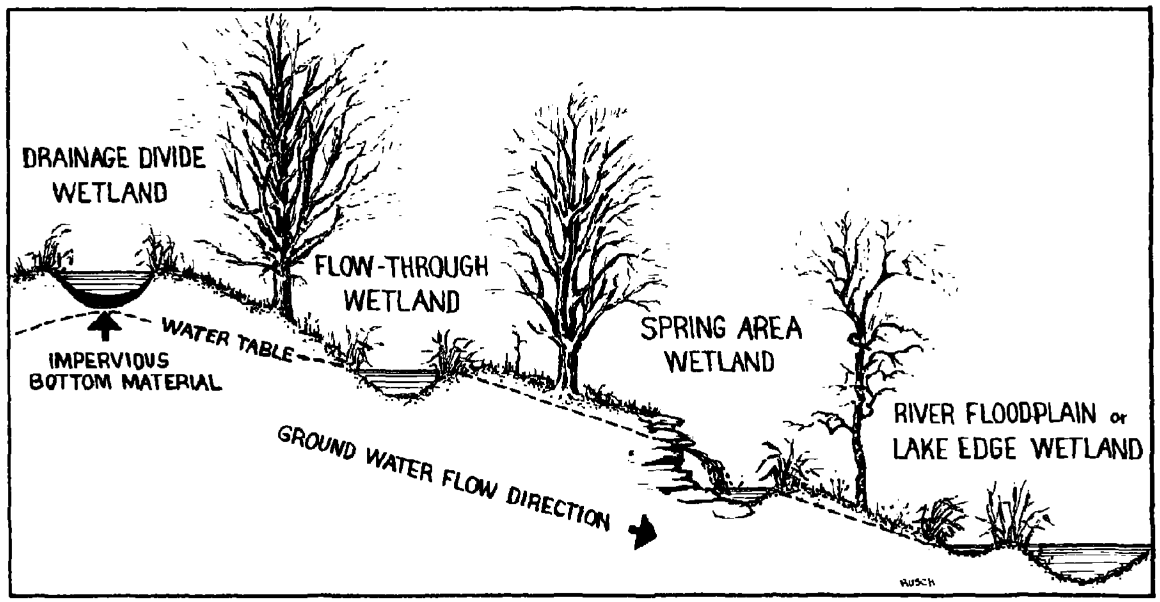


Fig. 2 Wetlands and Groundwater

Wetlands may occur in any part of the landscape from the upland drainage divide to the river floodplain or lake edge in the lowlands.

Wetlands which occur at the highest point in the hydrologic system, the drainage divide, are usually small. Most drainage divide wetlands have a bottom seal of fine-grained sediments that prevents much water from entering or recharging the groundwater.

Upland slopes may have wetlands where a dip in the land surface intersects the water table. Water generally flows out of the ground on the upper side of these wetlands and reenters the groundwater system on the lower side. As with drainage divide wetlands, relatively impermeable sediments may separate these wetlands from the groundwater system.

Upland wetlands may also form near springs. Spring areas are similar to flow-through wetlands in that water emerges from the groundwater system on their upper side, but in spring areas, the water does not reenter the groundwater system on the lower side. Water usually leaves these spring or seepage areas as small streams.

Finally, wetlands are common at the lowest point in the hydrologic system—in river floodplains and lake margins. Water flows out of the groundwater system through these wetlands and into rivers or lakes.

The wetlands described above are usually discharge areas—places where water flows out of the ground. But wetlands may become recharge areas in spring or fall when their water levels are higher than the water table due to heavy precipitation, saturated soils, and low evapotranspiration rates.

Soils of Wetlands

Wetland soils are distinctive because they form in waterlogged areas. They may be composed mainly of mineral materials (sand, silt, and clay) or organic materials (peat and muck). Some wetlands include both soil types, with mineral soils occurring where the ground is slightly higher. Wet mineral soils form where the water table is slightly below the land surface for much of each year. Peat and muck form where the water table is at or above the surface most of the time.

Wet mineral soils usually have thicker and darker surface layers than surrounding upland soils. Because of imperfect drainage, subsoil layers may contain mottles which are streaks and spots of rust and gray. Where the soil is very poorly drained, the subsoil may be almost entirely gray or bluish gray.

You can see the transition from well drained upland soils to wet mineral and finally peat or muck soils where land slopes gently down to a wet depression or lake (Figure 3). On the upper slopes, the grayish brown to dark brown topsoil is relatively thin. The underlying subsoil is brown or reddish brown and free of mottles. Such soils are **well drained** and support upland vegetation. Toward the bottom of the slope, mottles begin to appear in the lower subsoil. Farther down the slope the mottles come closer to the surface and the surface layer becomes slightly thicker and darker. When mottling comes within a foot of the surface and the subsoil color is very drab, the soil is usually **somewhat poorly drained.** Here, native vegetation is different. This is the transition zone from upland vegetation to wetland vegetation.

Slightly farther down slope, and closer to the water table, the topsoil thickens and becomes very dark. Here the subsoil is olive gray or bluish gray. Such soils are **poorly** or **very poorly drained** and support plants such as grasses, sedges, scattered elm, and other water tolerant plants.

Down slope a little farther, the water table is at or slightly above the land surface. Here peat accumulates as the dead plants remain saturated and decay very slowly.

Most peat and muck soils in Wisconsin are found in shallow lake basins or other low lying glacial depressions or in shallow bays of large lakes. In a lake basin, organic soils form as sediments accumulate on the lake bottom (Figure 4). These sediments include dead organic material from algae and other plants, along with soil washed in from surrounding slopes. Undecomposed organic soils are fibrous and often layered or matted. These soils are commonly called peat. They contain easily identified pieces of leaves, stems, and roots of plants such as reeds, sedges, or mosses. Some peat contains woody plant parts. Most peat has several kinds of plant material in layers, as shown in Figure 4.

When the water table in a peat deposit drops and the peat dries out, the peat shrinks, pulls apart, and air enters. This environmental change encourages bacteria, mites, earthworms, and other soil creatures to multiply and break down the plant materials. As peat decomposes, it changes into a darker material called muck (see surface layer, Figure 4). Muck is less fibrous than peat and has a granular or blocky structure. Often a layer of muck will have peaty material underneath. This is particularly true in drained and cultivated areas where artificial drainage lowers the water table several feet.

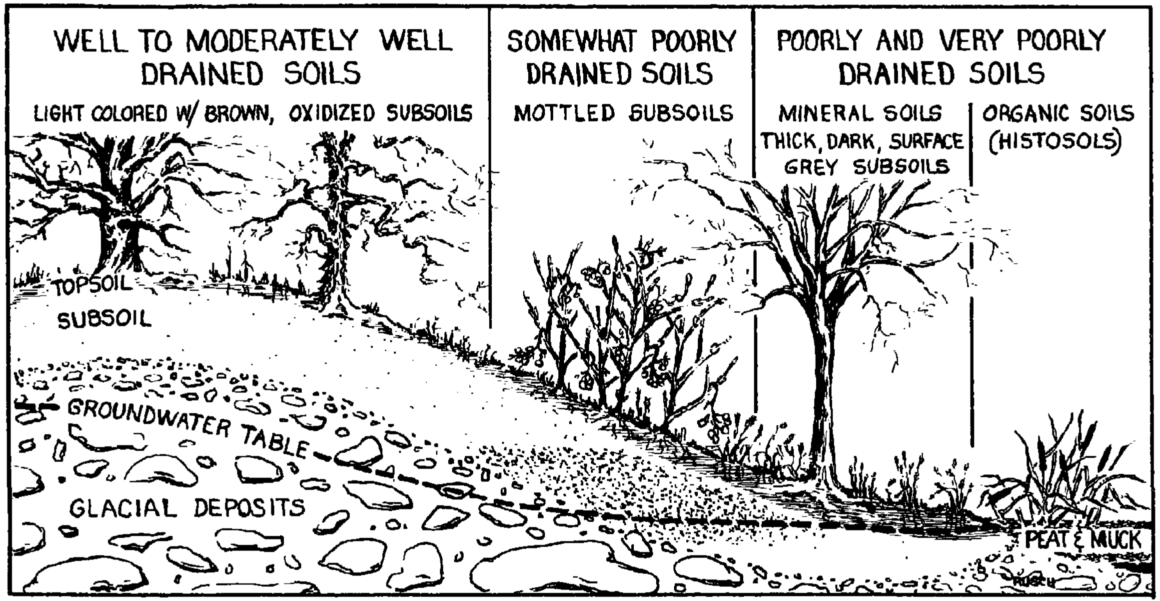


Fig. 3 The Relationship of Soils to Topography in a Southern Wisconsin Wetland

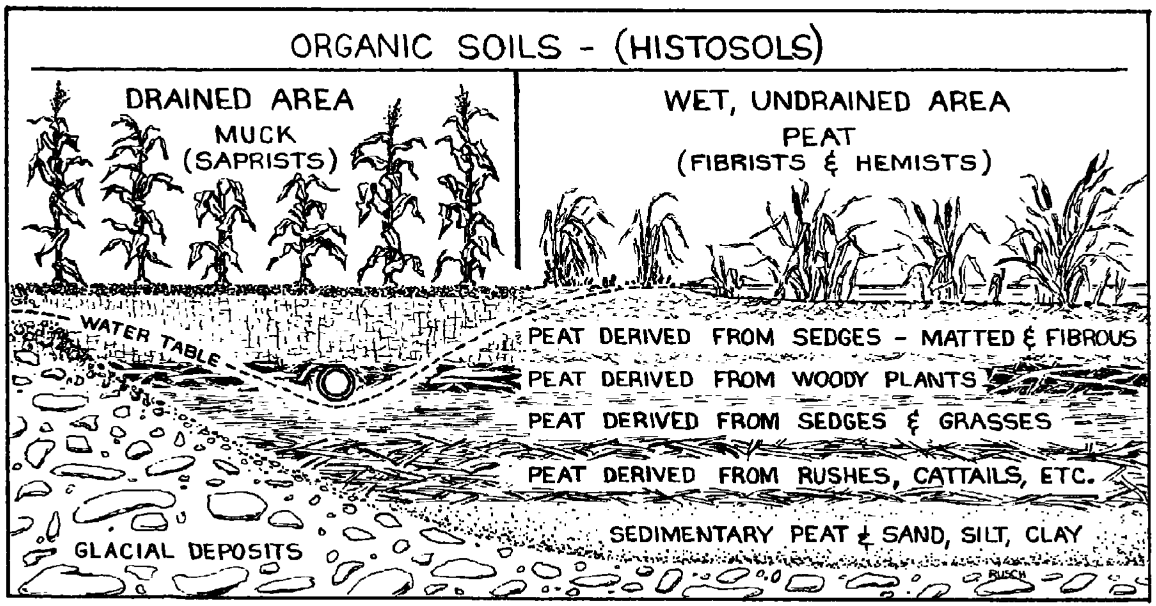


Fig. 4 The Structure of Peat and Muck

Plants of Wetlands

The kind of soil, water depth, soil and water chemistry, and climate determine not only the kinds of plants but their quantity and distribution within a particular wetland. As illustrated in Figure 5, the plants of most southern Wisconsin wetlands are different from the plants found in the cold acid bogs common to the northern part of the state. The diagram also shows how vegetation changes with water depth. The deeper water of a typical wetland in southern Wisconsin contains completely **submerged** plants such as coontail, muskgrass, and milfoil. Shallower water has plants like water lilies with long, flexible stems and leaves **floating** on the surface. Leaves of **emergent** vegetation such as arrowhead and pickerelweed may rise above the water. In even more shallow areas, burreed and cattails may grow. In the saturated soil of the wet meadow along the marsh edge, a variety of sedges and grasses grow. Shrubs such as willow, alder, and dogwood may also grow in the wet meadow. The same is true of water-tolerant trees such as elm, black ash, and cottonwood.

A bog, which is a type of wetland more commonly found in northern Wisconsin, has fewer submerged plants because sunlight does not readily penetrate its brown, tannin-stained water. However, plants with floating leaves and flowers such as the yellow pond lily or spatterdock are common in the open, shallow waters. Sphagnum moss, the dominant plant of most bogs, forms a floating mat, pieces of which may break off and form floating islands. Unusual plants such as the pitcher plant and sundew, which feed upon insects, may grow on the sphagnum mat. Leatherleaf, Labrador tea, bog Rosemary, and bog laurel, all evergreen, are among the more common bog shrubs, as are blueberry and cranberry. Tamarack and black spruce trees often thrive in bogs.

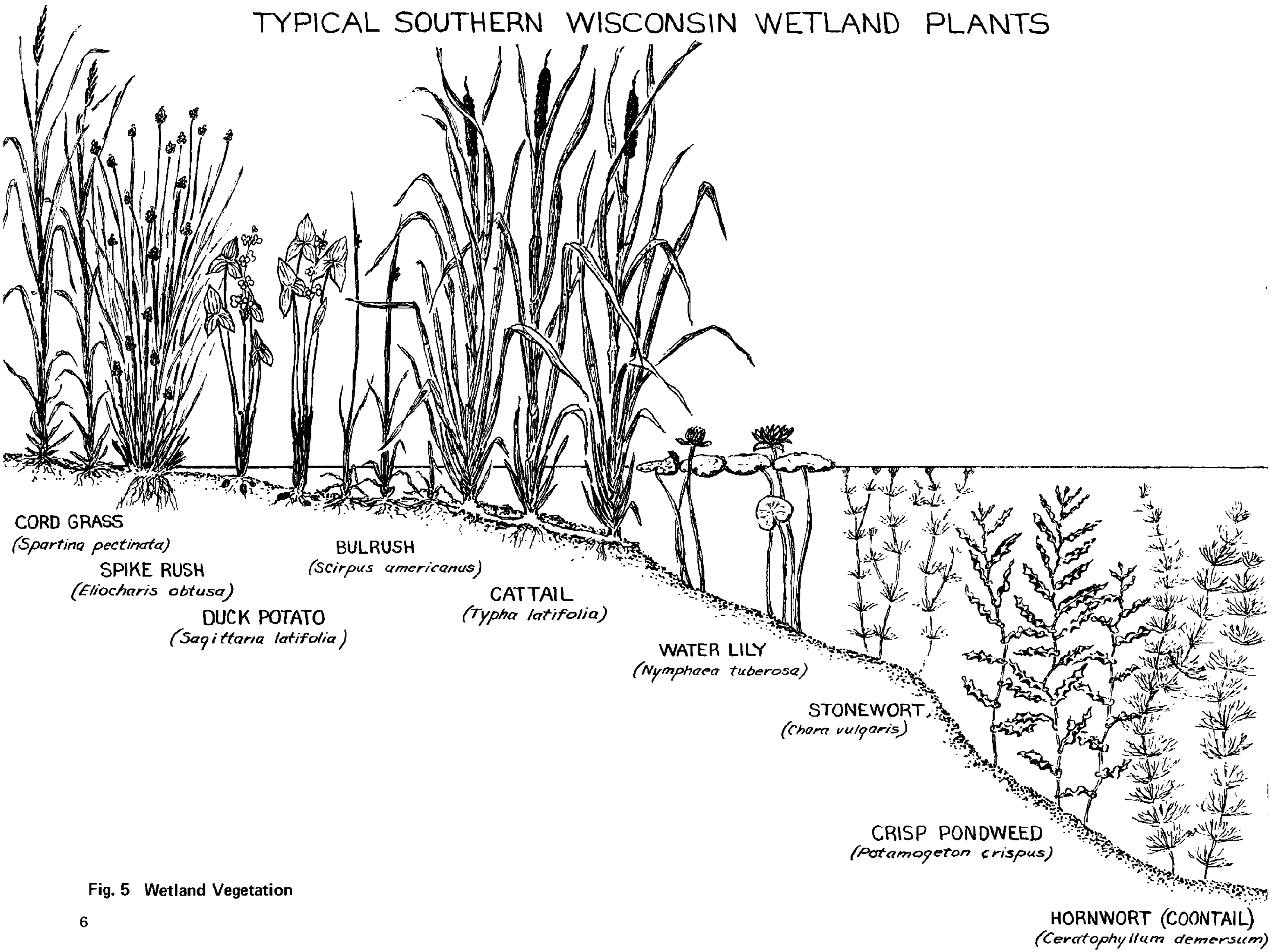
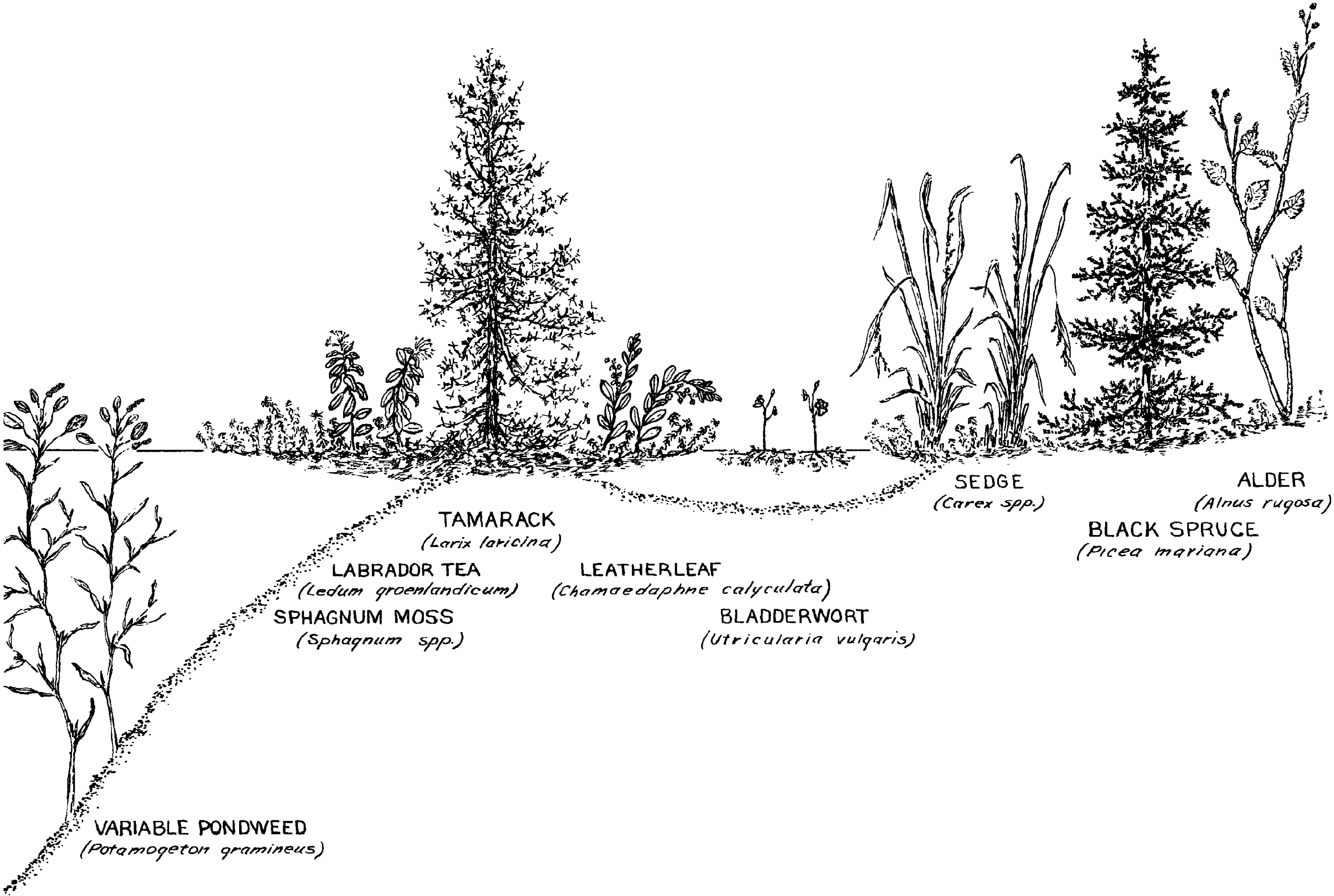


Fig. 5 Wetland Vegetation

TYPICAL NORTHERN WISCONSIN BOG PLANTS



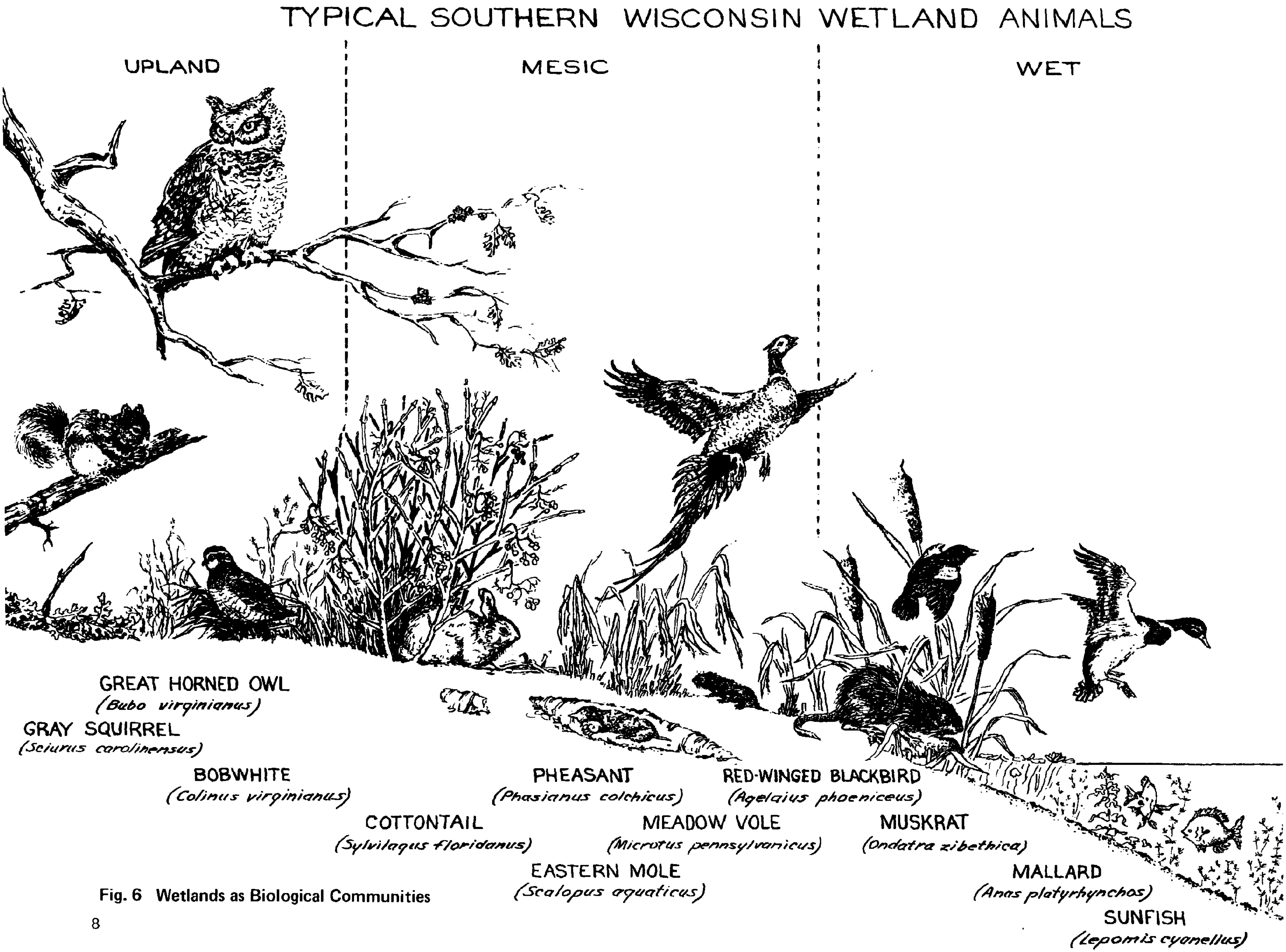
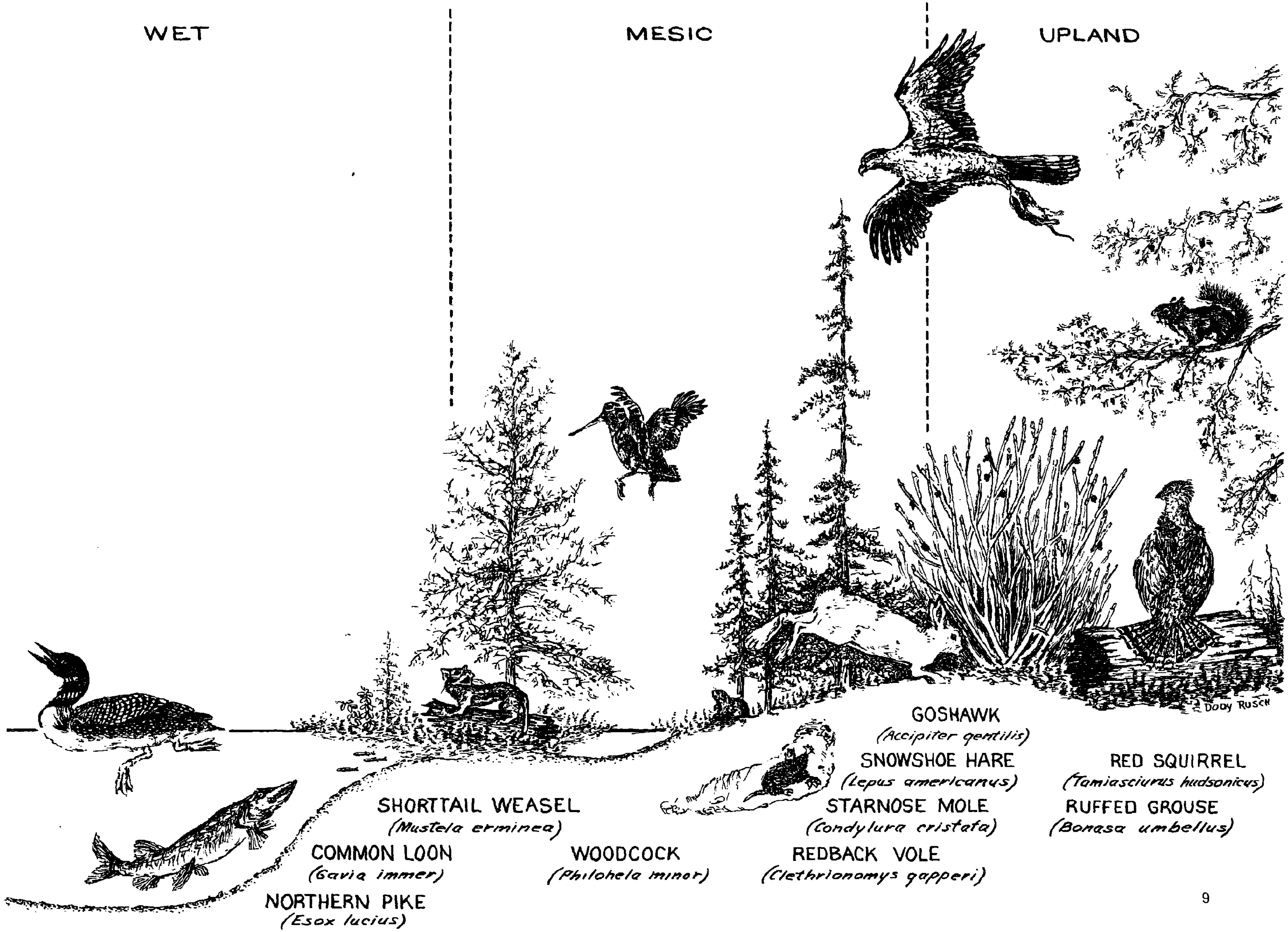


Fig. 6 Wetlands as Biological Communities

TYPICAL NORTHERN WISCONSIN BOG ANIMALS



THE ECOLOGY OF WETLANDS

There is no sharp dividing line between the wetlands of northern and southern Wisconsin. The type and abundance of wetland plants gradually changes from the cold, nutrient-poor waters in the north to the warm, nutrient-rich waters in the south. So in describing a typical northern and southern wetland, we must oversimplify.

In addition, the pattern of the types and locations of plants within wetlands is much more complex than we have suggested. In reality, the continuing interaction of water, soils and climate gives each wetland its own unique character. Because wetlands are complex and continually changing natural systems, ecological concepts such as plant succession, communities, the food web, and the energy pyramid help provide a basic understanding of wetland processes.

Plant Succession

If we could watch a wetland over many years, some remarkable changes would unfold. For example, a small pond two or three feet deep in the center of a wetland might accumulate soil particles carried in by wind and water. Decaying plant and animal remains might also collect in the depression, gradually filling the pond with soil and organic debris.

Next, grasses and sedges might obtain a foothold, only to be replaced by woody shrubs and trees. In the end, an entirely different wetland community might develop with its own characteristic grouping of plants and animals.

This entire process, the replacement of one type of plant by another as environmental conditions change, is known as **plant succession.**

The speed of plant succession depends greatly on the kind of soil, water quality, temperature, and precipitation. Disturbances such as fire, flooding, and sedimentation also may alter the course of plant succession. Nonetheless, barring such disruptions, plant succession is a continual process. In wetlands, it usually follows an orderly and predictable change from aquatic to terrestrial plants over a long time. Animal succession accompanies plant succession because animals depend on specific plants for food and cover.

Figure 6 shows the phenomenon of plant succession, which is the progressive change in plants and animals which occurs as the open water gradually evolves toward drier conditions. These cross sections are typical of many northern and southern wetlands having a variety of successional stages at the same time. This variety of habitats supports many animals.

Communities, Food Webs, and Energy Flow

At first glance, wetlands may seem to be areas in considerable disarray because of the mixture of plants and animals. In reality, there is a great deal of order. Just as groups of people live together in communities, depending upon each other for their specific needs, so do plants and animals.

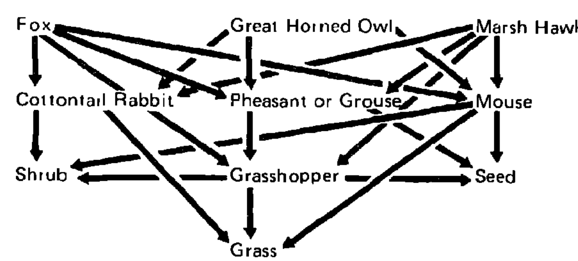
Within any biotic community, all plants and animals are linked by a vital and never-ending demand for food. The relationship between animals and the food they eat can be depicted in a diagram called a **food chain.** Here are some simplified food chains involving species shown in Figure 6.

Fox ↓ Cottontail Rabbit ↓ Shrub

Great Horned Owl ↓ Pheasant or Grouse ↓ Grasshopper ↓ Grass

Marsh Hawk ↓ Mouse ↓ Seed

There are actually many cross overs between food chains in natural plant and animal communities. The pheasant may eat seeds, the great horned owl may catch mice, the cottontail may eat grass, and the fox may prey upon pheasants. The net result is a **food web.** A food web involving the animals listed above would look like this:



The key to these food relationships is energy. All living things need energy to live, grow, and reproduce. The energy pyramid in Figure 7 shows that the sun provides the initial energy for the wetland. Green plants capture the sun's energy, combine it with carbon dioxide from the air and with water to manufacture energy-bearing food. Of course animals cannot capture the sun's energy for themselves and thereby manufacture their own food, so they consume the wide variety of plants within a wetland as their energy source.

Plants depend upon certain nutrient and hydrologic cycles which ensure their growth and survival. Disruption of these cycles, or the plant-animal food relationships and energy pathways, can have repercussions throughout the biotic community. Because of these relationships, the best way to manage the numbers and kinds of plants and animals in a wetland is to deal with the entire community rather than attempt to manage an individual plant or animal species.

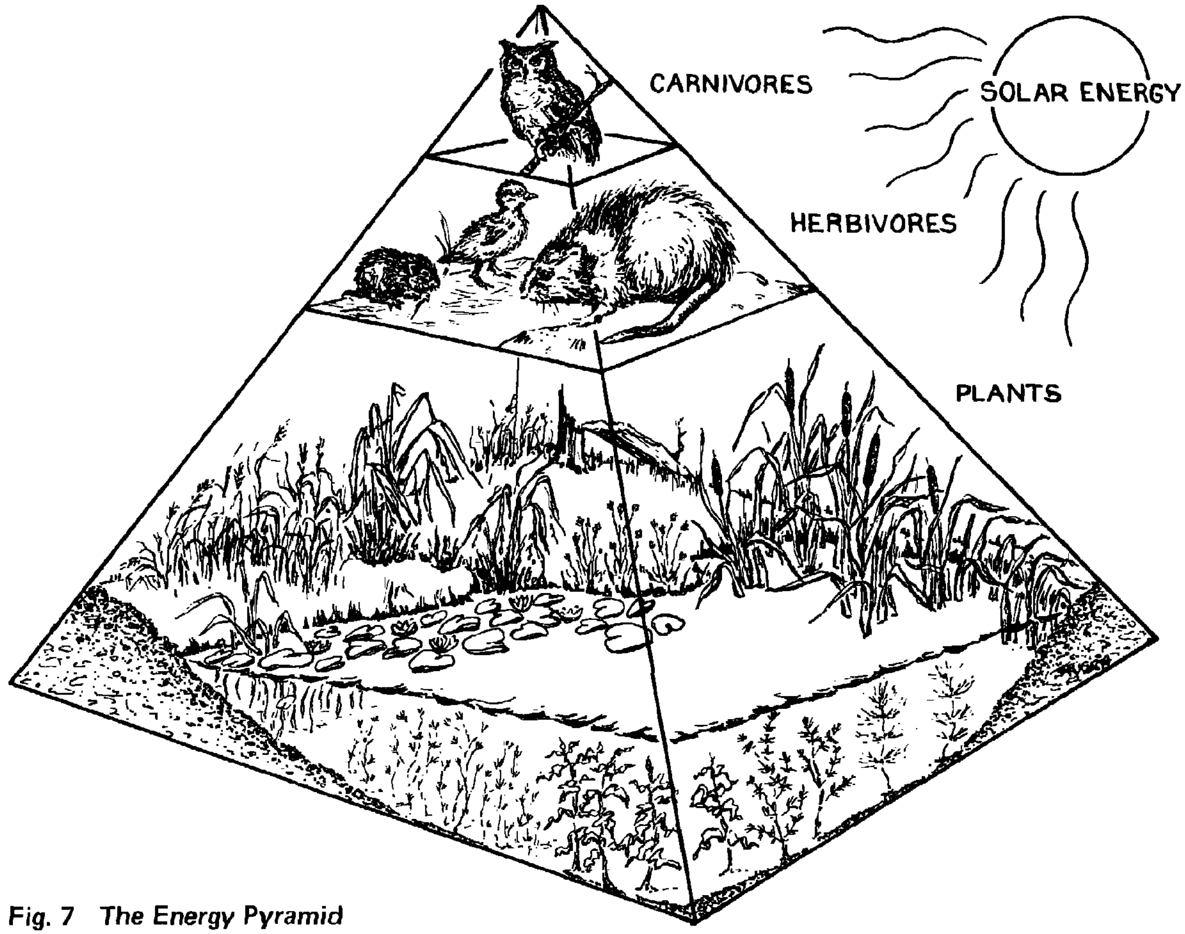


Fig. 7 The Energy Pyramid

USES OF WETLANDS

In their natural state, wetlands can provide habitat for wildlife and fish, serve as outdoor classrooms, provide open space, reduce flood peaks, and help maintain water quality. Wetlands can be altered for other uses—filled for urban development, dredged for recreational uses, or drained for agricultural production.

Natural Uses

Wetlands are especially important to the wildlife resources of Wisconsin. The moisture in wetland areas helps produce lush vegetation, furnishing food and cover for animal life. Acre for acre, wetlands usually support a greater variety and number of animals than any other biotic community.

Many species of mammals, birds, reptiles, and amphibians depend entirely upon wetlands for their survival at one time or another during their life cycles. Muskrats, ducks, water snakes, and leopard frogs can survive only in a wet environment. Mallards, teal, and wood ducks depend upon wetlands to rear their young. A large portion of Wisconsin's waterfowl harvest consists of these species which are born and mature within the state.

Still other species of wildlife depend upon wetlands in some areas simply because all other forms of suitable habitat have been eliminated. This is especially true of some agricultural lands where clean-farming has removed vegetation from field borders, fencerows, roadsides, and waterways. Under these conditions, wetlands may be the only remaining areas providing year-round cover for white-tailed deer, pheasants, cottontail rabbits, chorus frogs, and a long list of songbirds and small mammals.

Catastrophic events such as fires, drouths, and excessive snowfalls may also force wildlife to retreat to wetlands for food and cover. Deer, pheasants, cottontails, and furbearers such as muskrats congregate in wetlands during winter, as hunters and trappers well know. The overwinter survival of many wildlife species is linked directly to wetland cover, and these survivors are the next year's breeding stock.

Wetlands bordering lakes and streams provide spawning grounds for northern pike, walleye, and muskellunge. The abundance of aquatic insects makes these areas ideal for feeding. The diverse submerged and emergent vegetation shelters smaller fish from predators. As wetlands trap nutrients and sediments, they maintain water quality and enhance the survival of sight-feeding fish in adjacent waters.

Wetlands serve as ideal outdoor classrooms. Children and adults can directly observe the rich variety of plant and animal life in most wetlands. Wetlands clearly show the relationship of one organism to another and to the physical environment. Bird watchers find wetlands good places to observe waterfowl, marsh wrens, swamp sparrows, bitterns, snipe, grebes, and rails. Many other birds come to wetlands to feed on aquatic insects or fish, and to nest on or near the shores.

The state scientific area system contains undisturbed examples of wetland types set aside for study and research. These tracts of land are protected and managed to preserve native plant and animal communities.

Wetlands provide open space in urban areas. Wetlands with open water or unstable organic soils are difficult and expensive to develop. These types of wetlands are often some of the last areas to be converted to urban uses. If preserved, the unique blend of water and aquatic plants and animals common to wetlands and the open space provides visual contrast in urban areas.

Wetlands help reduce flood damage by collecting runoff during heavy rainfall and snow melt. By slowly releasing stored flood waters,

they reduce heights of floods and lessen downstream flood damage from water and sediment. A river floodplain forest is a particularly important type of wetland because it acts as a natural reservoir when rivers and streams overspill their banks. Upland wetlands also temporarily store flood waters from surface runoff.

Wetlands trap and store nutrients and sediments which might otherwise lower the water quality. Excessive nutrients can over-fertilize a lake, bringing rampant weed growth and algae blooms. Wetland plants take up phosphorus and nitrogen, keeping a portion of these nutrients out of lakes. Water flows through wetlands slowly, allowing time for sediment to settle out. Although flood waters may occasionally flush nutrients and sediment from wetlands, this usually happens during seasons of the year less critical to the lake environment. Obviously, filling or draining wetlands severely reduces their filtering action. Also, when wetlands are drained, nutrients stored in peat or muck often are discharged into adjacent lakes or streams.

Developed Uses

Wetlands provided early residents of Wisconsin with abundant food and furs. Indians hunted and trapped on wetlands and gathered wild rice, cranberries, and blueberries. Settlers arriving around the 1850's also used the wetlands for hunting and food gathering. They cut timber from the wooded wetlands and harvested wild hay from the wet meadows. Timber and hay harvesting altered the wetlands, but still left them **wet** and able to support natural plant and animal communities. However other wetland uses followed which drastically changed wetlands. (See Wetland Use in Wisconsin: Historical Perspective and Present Picture, listed in the bibliography.)

Urban Development. Some Wisconsin cities, particularly those near rivers and lakes, are built partly on converted wetlands. Downtown Milwaukee is located on what was once a large marshy area along the Lake Michigan shoreline. Madison covers substantial areas that were wetlands. Many smaller Wisconsin cities grew up along rivers which provided transportation and water power. The wetlands and floodplains of these river towns were filled and built upon to get easy access to the water.

As cities expanded, wetlands were filled to make room for new development. Many people considered wetland loss an inevitable part of urban growth. Today, however, people are concerned about too much wetland conversion, particularly in our heavily populated urbanizing areas. People are recognizing that: (1) as wetlands become more scarce, their value increases as rare and unique parts of the urban landscape; (2) once a wetland is built upon, it is lost forever; (3) development on wetland soils means greater costs of maintaining roads and utilities, and means leaky basements, septic tank failures, and flood damage in low-lying areas; and, (4) a good subdivision layout can incorporate a wetland to preserve open space, provide recreational benefits, and maintain other wetland values.

Recreational Development. Housing development around many Wisconsin lakes involved filling in wetlands. Typically, the high, well-drained shorelines were the first areas developed for homes and cottages. Then, as the best locations were built up, development moved to low-lying areas. Some Wisconsin lakes have the entire shoreline built-up, sometimes with several rings of homes. Concern over the loss of the protective function of wetlands, loss of spawning grounds, and pollution from failing septic tanks installed on wet soils led Wisconsin to pass a shoreland protection law in 1966. Resulting county ordinances now regulate development of wetlands next to lakes and navigable streams in unincorporated areas.

Wetlands next to lakes are sometime dredged to provide boat access. Dredging also removes unwanted sediment from wetlands and shallow lakes. Another method of deepening wetlands and lakes is to dam streams to raise the water level. In some cases, it is possible to manage lakes and wetlands by removing sediment and manipulating water levels, but this must be done carefully and skillfully to avoid destroying the natural values.

Agricultural Uses

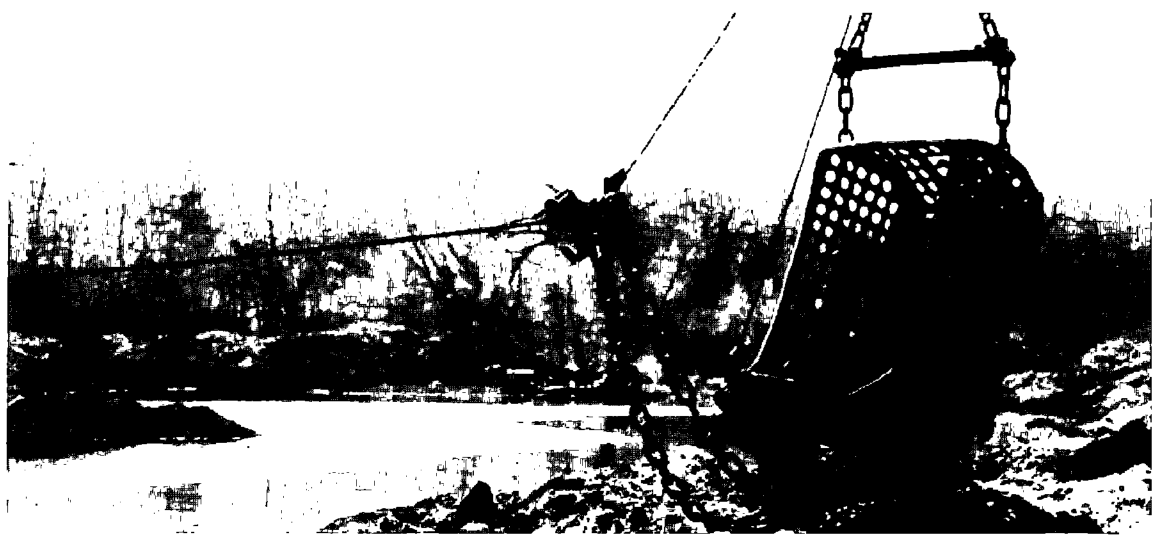
About 15 million acres of Wisconsin's 35 million acres of land are used for agricultural cropland and pasture. Included in the 15 million acres of cropland and pasture are about 4-1/2 million acres of wet soils. Approximately 3 million acres of these wet soils have been drained for agricultural use, the rest is used without drainage—mostly as pasture.

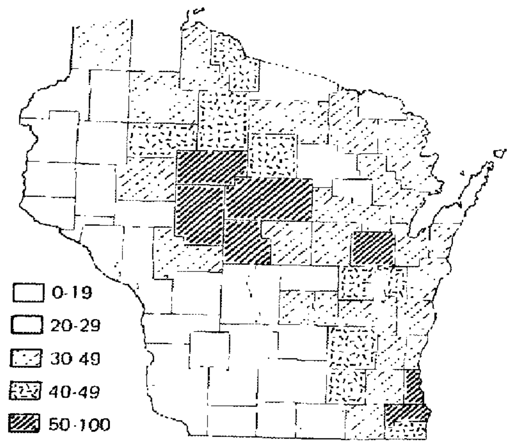
The rate of agricultural drainage has varied over the years depending on general economic conditions, market demand for agricultural products, the form of drainage laws, and federal financial assistance to develop wetlands for farming. Most of the wet soils drained in the last fifty years for farm use went into feed crops, especially corn. Other wetlands were drained for specialized crop production.

We don't know exactly how many acres of wetlands were drained for cropland or used as pasture. The best available figures, from the 1970 Soil and Water Conservation Needs Inventory, are summarized by counties in Figure 8 as the percent of soils classified wet, and the percent of wet soils used for cropland or pasture. Most of these wet soils were once wetlands.

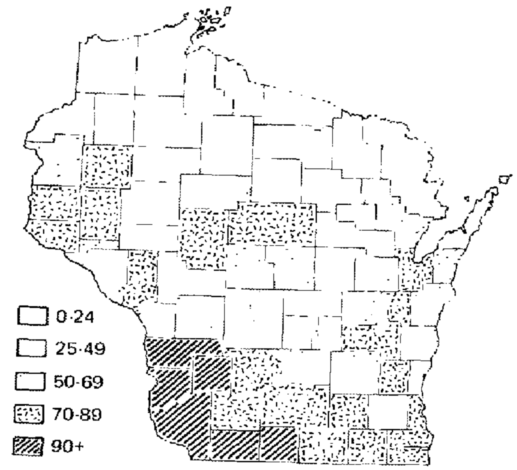
As the maps show, Marathon, Taylor, Clark, Wood, and Outagamie counties in central Wisconsin have the largest percentage of wet soils. The information for the heavily urbanized counties around Milwaukee is misleading because the inventory covers only unincorporated areas and they have a disproportionate share of the wet soils. Wet soils, being less attractive for urban development, have remained in agriculture.

Cropland is the major use of wet soils in the band of eastern counties from Oconto and Outagamie to Dane and Green. The limited acreage of wet soils in southwestern counties is heavily used for agriculture, mostly pasture. Most wet soils in far northern Wisconsin are in forests, rather than agriculture. Agricultural use of wet soils elsewhere in the state is about evenly divided between cropland and pasture.

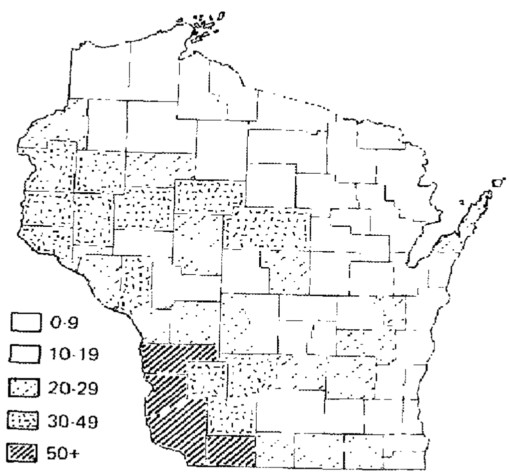




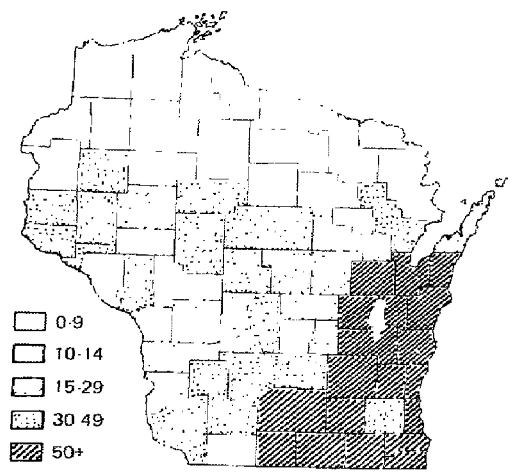
Percent of Soils Classified as Wet



Percent of Wet Soils in Agriculture
(Pasture and Cropland)



Percent of Wet Soils in Pasture



Percent of Wet Soils in Cropland

Fig. 8 Wet Soils of Wisconsin and Their Agricultural Use

General Crop Use. General agricultural use of wetlands includes occasional cropping of wetlands during dry cycles, cropping seasonally flooded areas, and intensive cropping of large wetlands containing effective drainage systems.

Drainage can improve field operation, expand cropland area, or improve crop yields. Drained wetlands vary from seasonally high-water table mineral soils to deep-water peat marshes. Much agricultural drainage consists of draining potholes, low areas, and edges to eliminate short rows and detours and to improve operational efficiency.

Drained wetland soils often grow field corn, grasses, and soybeans. Row crops are usually grown because they offer high yield potentials and because wetland soils aren't suitable for crops such as alfalfa.

Not all wetlands are suitable for crop production because of the type of soil, lack of a drainage outlet, or a frost hazard. Frost damage is a serious risk in many areas because peat and muck soils occur in depressions where cooler air flows. Organic soils are good insulators and do not conduct heat to the surface fast enough to warm up this cooler air. Organic soils also warm up slowly in the spring. Generally air temperature lows will be about 8 to 10 degrees below surrounding uplands on cool nights. Before an organic soil is drained for agricultural production, the thickness of the peat or muck, its composition and chemical characteristics, and the nature of the underlying material must be considered. Farmers who don't consider these items may wind up with land useless for crops. Drained organic soils may sink or settle. When drainage systems are installed, removing excess groundwater, the soil shrinks. Organic soils may shrink from excessive oxidation if the water table isn't controlled. Wind erosion may deplete the soil and fires can burn dry peat and muck. *Organic soils need specialized* management, including soil conservation practices, to preserve their value for crop production.

Specialized Crop Production. For many years, organic soils have produced specialized crops such as *mint, cranberries, carrots, onions, and* lawn sod. The term **muck farming** describes this type of agricultural production.

Not all wetlands are suitable for specialty crops. Of the almost 3 million acres of organic soils in Wisconsin, only 80,000 acres (about 3%) grow specialty crops. For an organic soil area to grow specialized crops, *it must have* (1) *adequate drainage,* (2) satisfactory pH level, (3) sufficient soil depth, (4) adequate drainage outlet, (5) water table control, (6) reasonable potential to meet the cost of clearing and development, and (7) relatively low frost hazard. If properly selected, developed, and managed, these soils can provide an excellent economic return from specialized crops.

Organic soils are easily worked and have a high water and nutrient holding capacity. Because they are deep and loose, they are particularly suited to crops like carrots, onions, and potatoes.

Wisconsin is one of the leading states in using organic soils for crop production. Some Wisconsin counties producing specialized crops on organic soils are Marquette, Columbia, Jefferson, Walworth, Dodge, Racine, Fond du Lac, Dane, Portage, Waukesha, Waushara, and Oconto. Wisconsin leads the nation in cranberry production with over 40% of the nation's supply. Cranberries grow in 18 Wisconsin counties, with Wood, Monroe, Jackson, Oneida, Vilas, and Washburn counties having the greatest acreage.

The acreage of the important specialty crops produced yearly on organic wetland soils in Wisconsin is potatoes (10,000), mint (10,000), cranberries (8,000), lawn sod (7,000), carrots (2,700), lettuce (2,000), onions (1,500), cabbage (1,000), sweet corn (1,000), red beets (800), celery (500), and cultivated "wild" rice (200). Field corn and soybeans are often grown in rotation with specialty crops.

Future Agricultural Drainage. Many large wetlands appropriate for muck farming have already been drained. Substantial acreage is still being drained for agriculture along river bottoms, primarily in west central Wisconsin. However for the next few years, most drainage will be on small areas of wet mineral soils in southern Wisconsin. This part of Wisconsin has already lost a higher proportion of its original wetlands than any other part of the state.

It is difficult to predict the future prospects for drainage. It is estimated that adequate drainage has been installed on 1.2 million acres of the 2 to 3 million acres of potential agricultural land with an excess water problem. The rate of future drainage will depend upon economic conditions, market demand for farm products, changes in agricultural technology, and public policy.

Subtle Changes

The effects on a wetland are obvious when it is filled or drained to convert it to dry land. However, a wetland can be changed in more subtle ways. Partial filling, flooding, or dredging can destroy the gradual slope that runs from the upland though shallow water to deep marsh. This natural shallow edge is the link between land and water. With the loss of its characteristic plants and animals, the wetland food web is simplified and the ecosystem becomes unstable. The result can mean converting a biologically rich wetland to a relatively unproductive pond.

Pollution and siltation are other subtle threats to wetlands. Urban storm drainage and rural runoff can contribute silt, nutrients, salt, and other pollutants faster than the wetland can assimilate them. Wetlands can trap and store nutrients and sediments, but overloading can destroy this capability, reduce the wetland quality, and eventually destroy it.

Management to Maintain Wetlands

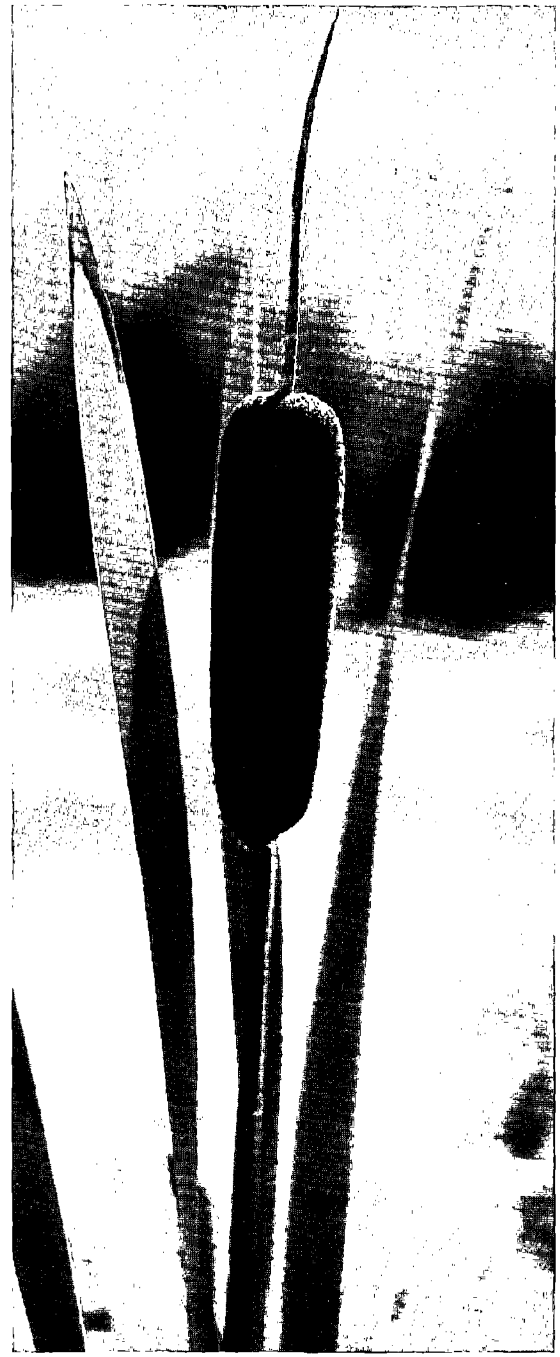
Wetlands can be managed to maintain their natural functions. In some cases man may change wetlands to enhance their biological productivity and improve or restore their other natural functions.

Preservation of selected, critical wetlands through public and private acquisition is an important but expensive wetland protection measure. However, funds are not available to acquire all wetlands that need protection. In addition, merely preserving wetland acreage does not automatically maintain natural wetland conditions. Wetlands are continuously changing. Plant succession, soil erosion, and water level fluctuation are all natural phenomena which occur even without human intervention.

Soil conservation practices help protect wetland conditions. Land treatment measures such as terracing, strip cropping, proper grazing practices, minimum tillage, small sediment control structures, and mulching can reduce runoff of sediments, nutrients, and other pollutants from farm fields and urban areas. These measures are beneficial not only to wetlands, lakes, and streams, but to the upland as well.

Sometimes wetlands need additional surface water to increase habitat diversity for plants and animals. We can increase the water level by constructing shallow impoundments using dikes or dams, excavating shallow potholes or ponds, and level ditching. These measures require great care for a variety of reasons; for example, removed material can become a source of nutrient leaching, and if the sides of holes are too steep, they will not support emergent vegetation.

We can restore former wetlands under certain conditions. Blocking the outlet drain will return a drained wetland to its former wet condition. Reestablishing previous native plant and animal communities is much more difficult.



DECIDING THE BEST USE OF WETLANDS

Wetlands vary in their suitability for agriculture or urban development and the importance of the natural functions they perform. But some wetlands are valuable for all these purposes. Today and in the future, we must decide the best uses of wetlands. Gain in food production through agricultural drainage or additional room for urban expansion must be weighed against the loss of the natural functions and environmental values of wetlands. Today's critical questions are whether the gain exceeds the loss, whether we can afford many more wetland losses, of what types and where, and how we should go about making these decisions.

The way wetlands are used affects us all as landowners, taxpayers, residents, and voters. Whether we are deciding the best use to make of a particular wetland or developing an overall policy toward managing the state's wetlands, it is fair to say at the beginning—"There is usually no clear or easy answer." But answers to these questions may help us decide:

1. What are the relative benefits and costs of alternative wetland uses?
2. Who pays these costs and who receives these benefits?
3. What legal rights and duties exist in relation to wetland use?
4. What tools can we use to guide wetland use?
5. What is our present policy toward wetlands?

Values of Alternative Uses

One way to determine the best use of a wetland is to let the decision be made by whoever is willing to pay the highest price. Let us assume a 20 acre wetland is located along a stream flowing into a lake. This wetland preserves water quality by trapping nutrients and sediment. If a developer will pay $2,000 an acre to fill the wetland for apartments and can outbid other uses such as agricultural production or preservation as a natural area, then the market price decides that apartments are the best use.

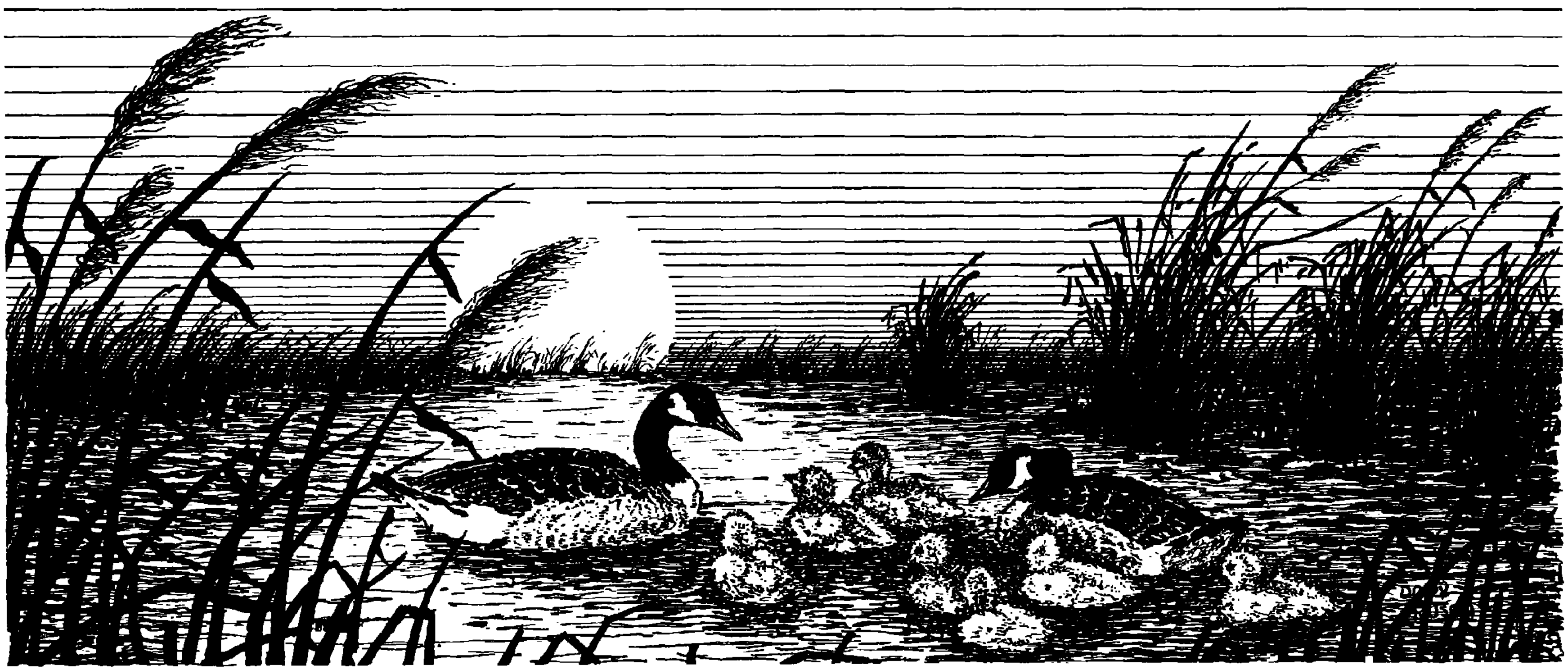
But many of the values of the natural functions of wetlands are not reflected in the market price. Some wetland values cannot be measured in dollars—for example whether Sandhill Cranes nest in Wisconsin. The benefit to society of a particular wetland use is the value of the goods and services it provides. The cost to society of using a wetland for one use is the opportunity lost for using it for another purpose.

In our example, we need to know the cost of placing the apartments in another location. In many instances, not building on filled wetland can mean a saving to the taxpayers. The cost of constructing and maintaining public facilities is greater on unstable wetland soils. Rarely does the developer pay all these costs. Frequently the general taxpayer must pick up major costs for increased road repair and sewer and water line maintenance. Publicly funded extension of sewer services is often necessary where malfunctioning septic systems in wet soils pose health and pollution hazards. Development on well-drained and otherwise adequate soils avoids many of these costs.

A dollar value can be placed on some wetland functions. For example, we can estimate what it would cost to construct facilities to accomplish the same results as a natural wetland provides. In our example, we could say the wetland is worth what it would cost to construct a treatment plant which would remove the same amount of nutrients that the wetland traps. These estimates are not easy to make and some of the assumptions on which they are based are open to argument. Generally speaking, however, these estimates show that many wetlands have a substantial dollar value to society if preserved as wetlands. Let us assume the value to society of preserving the 20 acre wetland is $5,000 an acre—a conservative estimate according to some studies. (See "Economic Criteria for Freshwater Policy in Massachusetts", listed in the bibliography.)

Who Benefits and Who Pays?

If many wetlands have such a high value to society, why are we losing so many of them? One reason is tied up in the question of who benefits and who pays. Our hypothetical $5,000 an acre figure measures **social** as opposed to **individual** benefits. Like many wetland benefits, these social values are broadly received by large numbers of people—lake property owners, swimmers, fishermen, and the general public. If a farmer owns the wetland, he will receive little direct economic value from preserving the wetland because most of the benefits accrue to those downstream. If the farmer wants to expand his cropland, he would ask two questions: (1) can I drain the land at a lower cost than buying more tillable acres, and (2) is the cost of drainage less than the expected value of my increased production? If the farmer answers **yes**, then it is in his economic self-interest to drain even though there is a cost to society. Of course, if he could sell the wetland to a developer for $2,000 an acre and buy other conveniently located cropland for $1,000 an acre, that would be his best economic course of action. But many farmers and other landowners help protect wetlands because they are more interested in their natural values than in receiving the highest possible economic return.



Public and Private Rights in Wetlands

Framing the problem in economic terms does not tell us how to solve it, but it does suggest some policy directions.

Let us return to our example 20-acre wetland. If the social value of preserving it is greater than filling it for urban development or draining it for agricultural production, the public would be benefited if the wetland were preserved and harmed if it were lost. However, the question remains: "Who should bear the cost of preservation—the public or the landowner?" This is not an economic question, but a political and a constitutional one.

A private landowner enjoys constitutionally protected rights to use his land in a variety of ways. Government can purchase (or condemn) land for a public purpose if it pays fair market value. Or, government may regulate land use without paying compensation if the landowner is left with some reasonable use of his property. The private property owner can appeal to the courts when he feels that government has infringed on his constitutionally protected property rights by taking property without compensation. Generally speaking, the government buys land for a public use or benefit but regulates it to prevent a public harm. But the distinction between paying for a public benefit and regulating to prevent a public harm is not always clear.

The Wisconsin Supreme Court faced the issues of public benefit vs. public harm, and regulation vs. purchase, in the 1972 case, *Just vs. Marinette County*. A property owner had filled a wetland next to a lake without obtaining a permit under the county shoreland zoning ordinance. The court characterized the issue of public benefit vs. public harm in the following language:

"In the instant case we have a restriction on the use of a citizen's property, not to secure a benefit for the public, but to prevent a harm from the change in the natural character of the citizen's property. We start with the premise that lakes and rivers in their natural state are unpolluted and the pollution which now exists is man-made. The state of Wisconsin under the trust doctrine has a duty to eradicate the present pollution and to prevent further pollution in its navigable waters."

In response to the landowner's argument that the regulations were an unconstitutional taking of property without compensation, the court stated:

"The Justs argue their property has been severely depreciated in value. But, this depreciation of value is not based on the use of the land in its natural state but on what the land would be worth if it could be filled and used for the location of a dwelling. While loss of value is to be considered in determining whether a restriction is a constructive taking, value based on changing the character of the land at the expense of harm to public rights is not an essential factor or controlling."

This decision does not mean that the court will always uphold government regulations which prevent wetland alteration. Each case must be decided on it facts. The court pointed out: "This is not a case of an isolated swamp unrelated to a navigable river or stream, the change of which would cause no harm to public rights." Our legal and political system is continually faced with the problem of defining rights to property and selecting the appropriate tools to carry out the public policy.

Government Guides Wetland Use

Private individuals own the vast majority of Wisconsin wetlands. The private owner exercising the rights and duties of land ownership is a key to wetland management. However, certain governmental powers can influence wetland management within the broader market framework.

This section begins with an overview of the various types of governmental tools available for guiding wetland use. It then examines our present wetland policy and the use of these tools. Finally, it discusses proposed Wisconsin legislation affecting wetlands.

Government Tools. A variety of governmental tools at the local, state and federal levels can guide wetland use. Public ownership confers the rights to use wetlands for such purposes as parks, public hunting grounds, and scientific areas. Negotiated purchase or condemnation can add other land to public ownership. Acquisition can involve the total fee simple ownership of the land or only part of the bundle of ownership rights. Easements are one way of acquiring part of the rights from private owners. Affirmative easements give the public the right to enter land for such things as hunting and fishing. Negative easements take away certain of the landowner's use rights such as the right to erect billboards in scenic areas.

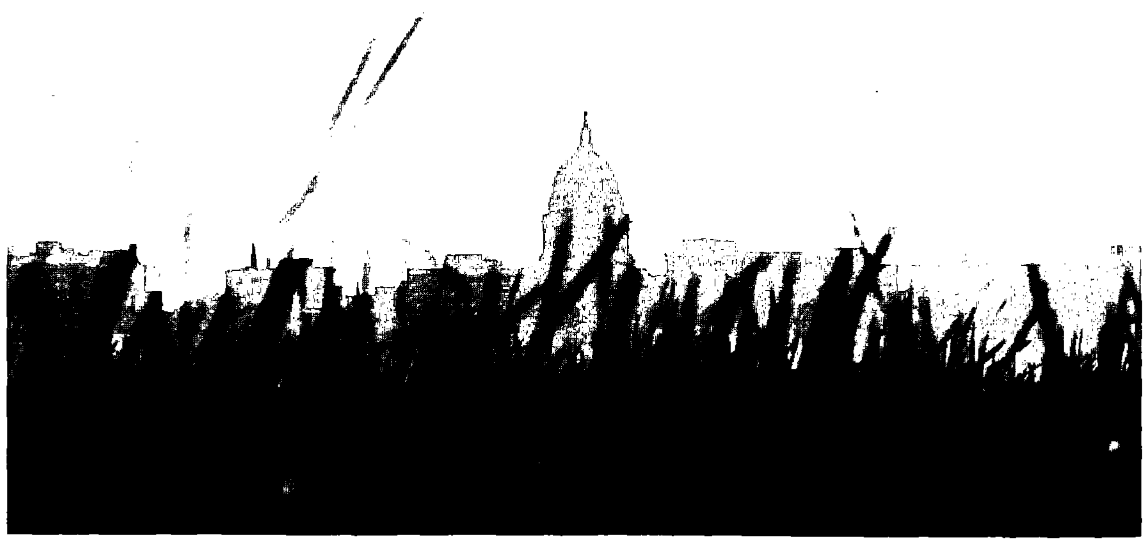
Other potentially valuable tools are regulations which directly or indirectly affect wetland use. Direct wetland regulation examples are requiring a permit for wetland alterations, and zoning of wetlands. Regulations requiring a permit for connecting to navigable waters do not control wetlands as such but do affect wetland drainage.

Financial and technical assistance from one level of government to another or from government to private individuals can help achieve certain wetland management goals. Taxation may also have an important impact. Lowering property taxes on wetlands could help reduce the pressure on private landowners to develop wetlands. State tax sharing with local government could minimize any loss in local tax base resulting from lowered assessments on wetlands.

Ownership, regulation, financial and technical assistance, and taxation are all tools for fashioning wetland policy. The next section looks at the existing laws which reflect present policies toward wetlands.

Our Present Policy Toward Wetlands. Many federal, state, and local laws affect the state's wetlands, but these laws often conflict. Some laws help to preserve wetlands; other laws encourage alteration. Since 1839, Wisconsin laws have offered some legal assistance to people interested in organizing to drain wetlands. The state's current drainage laws provide legal means of obtaining an outlet ditch through land owned by a person who may not want to be involved in the drainage project. The drainage laws also provide a procedure for assessing benefits and damages from the drainage project and for settling disputes over assessments.

Financial assistance from government for draining wetlands become available in 1938. From 1938 to 1974, the Agricultural Stabilization and Conservation Service (ASCS) offered cost-sharing money to farmers for drainage and other farm improvement practices. The Soil Conservation Service (SCS) has also offered technical assistance to farmers for drainage. Over 2,000,000 acres of Wisconsin's wetlands have been drained with ASCS funding assistance, but cost-sharing for drainage has been limited in recent years.



However, SCS and ASCS also have programs which protect wetlands. SCS offers technical assistance to landowners for erosion control programs which indirectly benefit wetlands. They also map and classify wetland soils and provide technical assistance for managing wetland wildlife habitat. A new cost-sharing program administered by ASCS directly encourages wetland preservation. Called the "Water Bank" program, it provides payments to private landowners who enter into a 10-year contract for maintaining wetlands and adjacent uplands as wildlife habitat. While the Water Bank has the potential for maintaining many privately-owned wetlands, shortage of funds has limited it to relatively few landowners in only a few counties.

Government agencies often preserve wetlands by acquiring them. Almost one million acres of Wisconsin's wetlands are now publicly owned. About 384,000 acres of the publicly-owned wetlands are in county forests. National forests and wildlife areas cover 325,000 acres of Wisconsin's wetlands. The remaining 276,000 acres of publicly-owned wetlands are in the state forests, fish and wildlife areas, or parks.

The state has purchased affirmative easements on some wetlands to provide public access for hunting and fishing. Wisconsin has not often used negative easements to buy the private landowner's right to drain or fill wetlands.

Some state-owned wetlands are designated as scientific areas. These wetlands are carefully managed to preserve their unique plant and animal communities. Private organizations have also purchased special wetland areas and turned them over to the state to be managed as scientific areas.

In addition to managing wetlands by acquiring them, governmental agencies have some jurisdiction over privately-owned wetlands. State and federal regulations concern privately-owned wetlands adjacent to navigable waters. The Army Corps of Engineers requirements for securing a permit for dredging and filling in navigable waters also applies to adjacent wetlands. However, Corps permits are not usually required for normal farming and forestry operations or drainage or irrigation ditches. Wisconsin Statutes require permits from the Department of Natural Resources for dredging, filling, connecting to, or otherwise altering navigable waters, but the law does not require a permit when individual farmers make agricultural connections.

The Wisconsin shoreland and flood plain zoning laws also offer some protection for wetlands adjacent to navigable waters. Counties have shoreland zoning regulations applying to unincorporated areas located within 1,000 feet of a lake, pond, or flowage or 300 feet from a river or stream or to the outer edge of the flood plain if that is a greater distance. Wetlands in the shoreland areas are usually zoned conservancy. Residential development is not allowed in conservancy districts but special exceptions may be granted to allow draining, dredging, filling, and other uses.

Flood plain zoning is required of cities and villages as well as counties. Only open space uses such as agriculture are allowed in the floodway—the part of the flood plain which carries most of the flood water. More uses are allowed in the floodway fringe—the edge of the flood plain which holds shallower, slower-moving water during a flood. Buildings may be constructed in the floodway fringe if flood-proofed—typically by filling the site above estimated flood heights. Thus, flood plain zoning restricts filling and building in wetlands which are in the floodway but allows filling and building development in wetlands in the floodway fringe.

Shoreland and flood plain regulations apply only to wetlands near lakes and navigable rivers and streams. Some alteration of wetlands within these areas is permitted, and the wetlands located outside these areas are not covered. Few counties have applied conservancy zoning outside shoreland areas and these regulations apply only in towns which have approved them. (For further information see Wetland Use in Wisconsin: Present Policies and Regulations, listed in the bibliography).

Proposed Wetland Legislation. Bills to establish a broader wetland protection program were introduced in the Wisconsin legislature the last several sessions. The 1975 bill proposed a permit system for wetland protection, administered by city, village, and county zoning agencies. Minimum state standards for local ordinances were spelled out. Permits to drain, dredge, fill, flood, or build in wetlands were required for certain types of activities. Other activities were excluded from the proposed regulations. Other proposed bills would have reduced property taxes on wetlands. If such legislation were to be passed, it would provide additional protection to wetlands and reduce tax pressures to develop them.

SUMMARY

We have looked at wetlands as physical features in terms of their water, soil, and plant and animal communities. We have viewed wetlands as resources that provide valuable natural functions and which can be altered for urban development, agricultural production, and other uses. Wetlands are an increasingly important resource because of the many demands we put on them and the large number we convert to other uses. Deciding the best use of wetlands isn't easy. We must consider the values of alternative wetland uses, who pays the cost and who receives the benefits, public and private rights in wetlands, and our present policy toward wetlands. We are all affected by the way wetlands are used, as taxpayers, landowners, citizens, and voters, and we can influence the future choices that will be made. We make such choices not only through the way we use wetlands today, but also through laws, policies, and programs that determine how wetlands will be used in the future. You can help make a difference by continuing to be informed, discussing your ideas with friends and neighbors, and sharing your opinions with governmental officials.

SLIDE AND TAPE SET

A tape-narrated slide set entitled *Wisconsin Wetlands* shows the valuable functions performed by wetlands in their natural state. It also shows the uses of wetlands for agriculture and urban development. It indicates we need a wetland policy to determine the proper balance between wetlands in their natural state, the crops they could grow or the building sites they could provide.

The set contains 65 numbered 35 mm slides and cassette tape narration with audible beeps. The set can be purchased for $25 from:

Bureau of Audio-Visual Instruction
1327 University Avenue
P.O. Box 2093
University of Wisconsin-Extension
Madison, WI 53701

ADDITIONAL INFORMATION

1. *Wetlands of Dane County Wisconsin*—Bedford, Barbara L.; Zimmerman, Elizabeth H.; and Zimmerman, James H. Dane County Regional Planning Commission, Madison, WI., 1975, 331 pp.

   This report is a detailed inventory of the wetlands of Dane County. It also includes a discussion of the values of wetlands and the relationship of wetlands to soils, geology, hydrology, and water quality. Ecological concepts and wetland management are also discussed.

   Available from: Dane County Regional Planning Commission, Room 312, City-County Building, Madison, Wisconsin 53709.

2. "Wetlands Chapter 5," pp. 37-51 in *Performance Controls for Sensitive Lands*—Planning Advisory Service Reports #307, 308 American Society of Planning Officials, Chicago, Illinois, 1975, 156 pp.

   Chapter 5 discusses wetland ecology, evaluates local wetland regulations and suggests ways to develop local wetland protection programs.

   Available from: American Society of Planning Officials, 1313 East Sixtieth Street, Chicago, Illinois 60637.

3. *Evaluation of Inland Wetland and Water Course Functions*—Lavine, David; Darichy, Charles; McCluskey, Dorothy; Petry, Liz; and Richards, Sarah W. Connecticut Inland Wetlands Project, Middleton, Conn., 1974, 166 pp. This publication provides information on the physical, biological and cultural functions of wetlands; suggests a method for inventorying and evaluating wetlands on a local basis; and includes two sample case studies showing how this information is used in making decisions under the Connecticut Wetlands Act.

   Available from: Connecticut Inland Wetlands Project, P. O. Box 124, Middleton, Connecticut 06457.

4. *Wetland Use in Wisconsin: Historical Perspective and Present Picture*—Johnson, Carolyn D. Wisconsin Department of Natural Resources, Water Resources Planning Section, Madison, Wis., 1976, 48 pp.

   This publication is an historical analysis of wetlands in Wisconsin. It describes the functions of wetlands, how many wetlands Wisconsin once had, how they have been used and how they are being treated presently.

   Available from: Department of Natural Resources, Box 450, Madison, Wis. 53701. No Charge.

5. *Wetland Use in Wisconsin: Present Policies and Regulations*—Heitz, Jean. Wisconsin Department of Natural Resources, Water Resources Planning Section, Madison, Wis., 1976, 25 pp.

   This report gives an overview of policies, regulations and laws which apply to wetlands. It provides background information for a consideration of alternative futures, policies and regulations for use of Wisconsin's wetlands. Available from: Department of Natural Resources, Box 450, Madison, Wis. 53701. No Charge.

6. "Economic Criteria for Freshwater Wetland Policy in Massachusetts"—Guptu, Tirath R. and Foster, John H. *American Journal of Agricultural Economics,* Volume 57, Number 1, February, 1975, pp. 40-45.

This article develops a criterion which can be used as a basis for deciding whether to issue or deny a permit to alter a wetland under the Massachusetts Inland Wetlands Act. The criterion involves a comparison between the social opportunity cost of a denial, as indicated by market price and the social value of four groups of wetland benefits.

Orders for individual volumes of the Journal should be sent to John C. Redman, Department of Agricultural Economics, University of Kentucky, Lexington, Kentucky, 40506.

7. *Protection of Wetlands*—Stute, Dave. Informational Bulletin 74-4, Madison, Wis., 1974, 28 pp.

   This report was prepared for use by a Wisconsin legislative committee which developed wetlands protection legislation. It describes constitutional issues and policy issues which should be considered when formulating wetland legislation.

   Available from: Wisconsin Legislative Council, State Capitol, Madison, Wis. No charge.

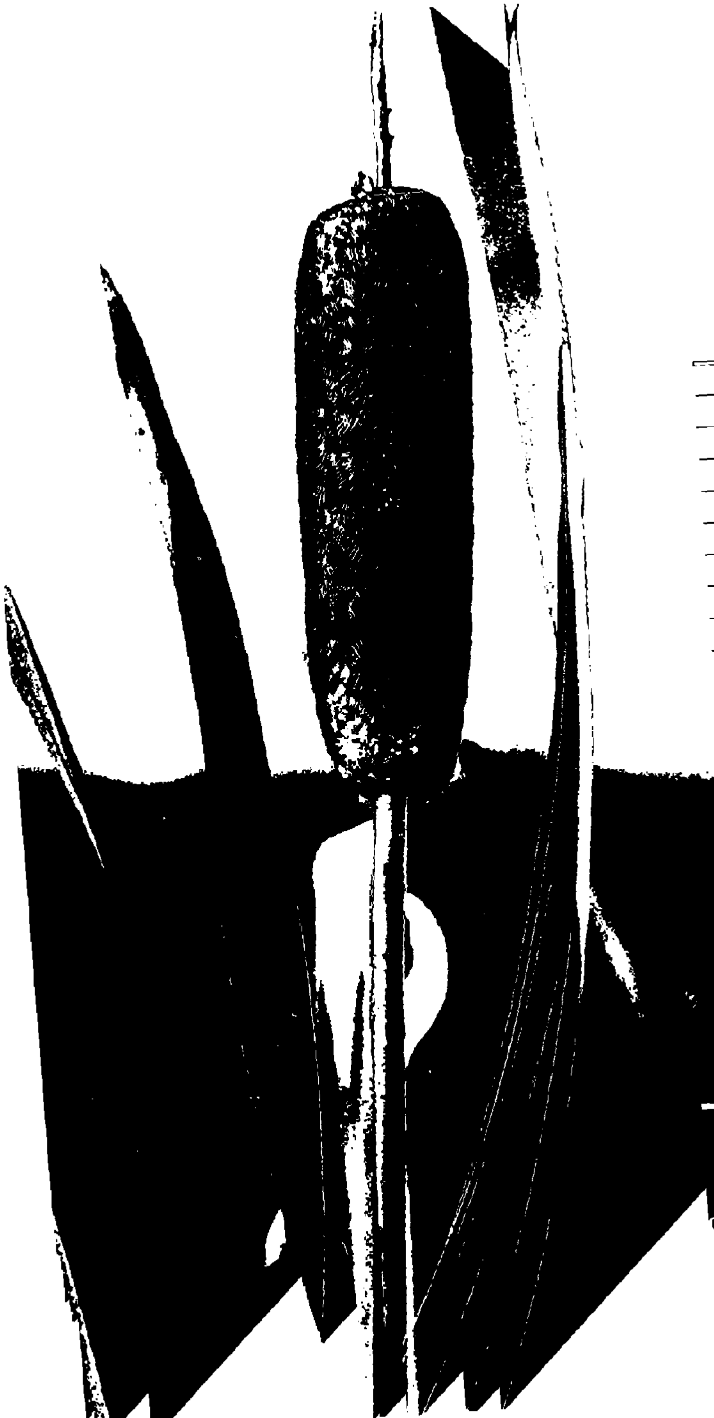
8. *Pond Life*—Reid, George K., Golden Press, New York, Western Publishing Co., Inc., Racine, Wis., 1967, 160 pp.

   One of the Golden Nature Guides, this publication is an introduction to the plants *and* animals that live in quiet fresh waters of North America. Emphasis is on life found in ponds, but included in the hundreds of species described and illustrated in color are many plants and animals that live in lakes, streams and wetlands.

   Available from: Most bookstores.

9. *The Hydrology of Wisconsin Wetlands*—Novitzki, R. P. (To be published at a later date by the U. S. Geological Survey or Geological and Natural History Survey—the University of Wisconsin-Extension.)

   A short lay report describing the hydrologic setting of Wisconsin wetlands and how this affects vegetation, soils, and water quality. Available from: U. S. Geological Survey or Wisconsin Geological and Natural History Survey, 1815 University Avenue, Madison, Wis. 53706. Price will be determined at time of publication.



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